

Dr. D. says: "Having heard the history of the case carefully stated, observing the leg and the lower part of the thigh to be in a state of dry gangrene, and seeing the marks of the bandage visibly impressed on the surface, my opinion was made up at the time that the gangrene had resulted from pressure of the bandage. The femoral artery at the groin was in a sound and natural state, and if I mistake not, after the limb was removed, it was traced to the point of obliteration where the gangrene commenced, and where the impression of the bandage was observed; thus far, I think, it was of natural size and calibre. Hence the conclusion is inevitable, that the death of the limb resulted from the pressure of the bandage, and not of one of the fragments.

"It was a curious specimen of dry mortification, and I regret that I did not use the means of preserving it. I was then engaged in a very laborious practice, thirty miles from home, on horseback, and consequently could not conveniently spare the time to attend to it as an object of surgical curiosity. Dr. H. and myself cut into the leg in various places, in order to examine the muscles, arteries, nerves, etc., but found the integuments so hard that it was really difficult to penetrate them with a knife; the resistance to the knife was more like that of dry hickory wood than anything else."<sup>1</sup>

It would seem almost superfluous to defend the use of side or coaptation splints in the treatment of fractures of the shaft of the femur. It will be remembered, however, that Radley, of England, and Dudley, of Kentucky, treated these fractures without side splints and without extension. In 1844 I found Jobert, at l'Hôpital St. Louis, employing only extension without side splints. Swinburn, of Albany, rejects side splints in all fractures of long bones, relying solely upon extension; and recently, I have been informed, Kronline, of Zurich, has recommended in the treatment of fractures of the thigh extension with the weight and pulley, without side splints.

I do not think that either of these gentlemen have ever made many converts to their peculiar views, yet it may be well to give to the subject a brief consideration.

Against side splints, considered independently of the means by which they must necessarily be maintained in position, there can be no possible objection. It is only the constriction, and obstruction to the free circulation caused by the bandages which bind them to the limb, to which any objection can be made. The same objection would hold against a roller applied directly to the skin, which by Dudley was substituted for the splints, but in a much greater degree, inasmuch as it is less easily removed or loosened in case the swelling increases the bulk of the limb. This I have always considered a valid objection to the roller applied immediately to the skin in this or in any other fracture, and as one of the reasons why the plaster-of-Paris dressings or any other form of immovable dressing is relatively unsafe. In a degree, also, this objection holds against the continuous roller as a means of holding the splints in place.

<sup>1</sup> For a more complete account of this interesting case, see Buffalo Med. Journ., vol. xiv. p. 193, Sept. 1858.

If side splints are light, properly adapted to the limb, with no rough or unequal bearings; if they are not bound too tightly to the limb; if they can be loosened or removed without disturbing the limb and are not continued beyond the period of their usefulness, they can do no harm, while they give important aid in preventing motion at the seat of fracture and in maintaining the fragments in line. This is especially true in fractures occurring through the middle portions of the shaft of the femur. If absolute quiet to the limb could be insured during the period of union, while asleep and while awake, if the patient had never occasion to move his head, shoulders, or nates, the protection usually afforded by side splints would be less needed; but even then the conical shaped limb would find a very unequal and inadequate support upon the straight surface of the mattress.

In short, in my opinion, the omission to employ side splints in most simple fractures of the shaft of the femur would greatly increase the danger of non-union and of deformity, and would therefore be inexcusable.

The treatment of these and other fractures by plaster of Paris, paste, starch, or dextrine has been already considered when speaking of the treatment of fractures in general. Thus far my experience will not warrant me in recommending the immovable apparatus, as a general plan of treatment in fractures of the thigh.

In the fourth edition I spoke somewhat more favorably of the results of this practice as declared by some of the house surgeons of Bellevue; still more lately one of the visiting surgeons has published some statistics which indicate a better average result than has been hitherto obtained by other methods; but having since learned that these statements were not based altogether upon measurements made by these well-known and able writers themselves, I am unwilling to accept of them as trustworthy testimony.<sup>1</sup> For a review of Dr. Van Wagenen's report of cases treated by the plaster of Paris in Bellevue Hospital, the reader is referred to the chapter on General Prognosis.

In order to assure myself as to whether we were able to make longer and straighter thighs by the use of the plaster of Paris than by the method of extension as employed by myself and others, my later experience has been carefully collated, but not selected; every case in which the opportunity was afforded being recorded, and the results being confirmed by my own testimony and the testimony of others. The facts thus obtained constituted the basis of an article written by me for the *New York Medical Journal*, and published in the August number for 1874; but the great interest taken in the discussion of the merits of Mathiesson's plaster-of-Paris dressings, both in this country and abroad, during the last few years, seemed to me to call for a statement of expe-

<sup>1</sup> Prof. H. B. Sands, N. Y. Med. Journ., June, 1871; Dr. J. D. Bryant, N. Y. Med. Record, Sept. 15, 1871; Dr. S. H. St. Johns, Amer. Journ. Med. Sci., July, 1872. Reply to Dr. St. Johns, by the author, Hosp. Gaz., etc., May 30, 1878; Dr. St. Johns's reply, Louisville Med. News, Sept. 28, 1878; Lecture on Fractures of the Femur in the Adult, Bellevue Hosp., by the author, Med. Record, Dec. 1, 1877; Dr. St. Johns, on the same, before Academy of Med., N. Y., May 14, 1878, Med. Record, July 20, 1878.

rience which should cover a large number of cases, although it could not be expected in a treatise like this to give all the cases in detail, as was done in the journal communication already referred to. Of the cases treated by plaster of Paris, and recorded in the accompanying tables, a majority were from the hands of other surgeons, and all were hospital cases; in almost every instance the surgeon treating the case having had a large experience in the use of plaster. With very few exceptions, the plaster was applied while the patient was under the influence of ether. After the plaster was applied most of the patients walked about with crutches; but there were pretty frequent examples in which, for one reason or another, this was found impracticable, and the patients remained in bed.

The amount of shortening has six times exceeded one inch. A considerable bend at the seat of fracture has occurred six times; ankylosis of the knee, requiring surgical interference, has occurred six times, and in almost all cases it has been more troublesome than it is usually found to be after other plans of treatment; once gangrene, amputation, and death followed, and once abscesses of the leg, paralysis, etc.

The cases reported as treated without plaster were all treated by myself. The method adopted being in the case of adults essentially that which is known as Buck's extension, but which I have, as will hereafter be seen, considerably modified. In the case of children, the method has been uniformly that which I shall hereafter describe in its proper place as the method preferred by me in these cases; permanent extension, such as is used in Buck's apparatus, being very seldom employed. Not one of these limbs has presented an excessive shortening—one inch being the maximum. Not one is bent at the point of fracture. None of the patients had bedsores, or troublesome ankylosis at the knee-joint. In one there was delayed union. Case 23 has been measured by many of the gentlemen connected with Bellevue, and all agree that the broken limb is longer than the other, yet it united promptly, and he walks without a halt. We have been unable, thus far, to find any other explanation of the increased length except the now well-established fact that the normal lengths of thighs and of other long bones are pretty often unequal, and that probably this limb was originally longer than the other. The experiments of Reid<sup>1</sup> and of others have conclusively shown, I think, that it is impossible, unless at least fifty or one hundred pounds were employed in the extension, to stretch the muscles beyond their normal length. If a limb after fracture and bony union is found longer than its fellow, no doubt it was longer before the fracture. We cannot, therefore, appreciate the objection made by Dr. Sayre to permanent extension by a weight and pulley, that it endangers a total separation of the fragments, and consequent non-union. Five children and one adult had perfect limbs; or, if we are permitted to include the case in which the limb is lengthened, two adults have recovered with perfect limbs.

<sup>1</sup> Reid, W. W., Buff. Med. and Surg. Journ., vol. vii. p. 134, Aug. 1851.

Cases treated with Plaster of Paris, Continuous Roller, Mathiesson's Method.

No.	Age.	Character of fracture.	Point of fracture.	Hospital.	Am't of short'g.	Deformity.	Remarks.
	Yrs.				Inches.		
1	11	Simple.	Middle.	Bellevue.	3/4	{ Slightly bent.	{ Ankylosis of knee.
2	15	"	"	St. Francis.	1 1/2		
3	16	"	"	Park.	1 1/2		
4	17	"	"	99th St.	1	Much bent	{ Ankylosis broken up under ether.
5	12	{ With frac. of legs.	{ Below troch. }	Park.	1	" "	
6	16	Simple.	"	Bellevue.	1 1/2		
7	7	"	Middle	"	1		
8	39	"	"	"	1		
9	37	"	"	"	1		
10	63	"	Extracap.	"	1 1/2		
11	26	"	Middle.	Park.	1 1/2		
12	24	"	"	"	1 1/2		
13	25	"	"	"	1		Ankylosis.
14	36	"	"	"	1 1/2		"
15	21	"	"	Bellevue.	1 1/2		
16	26	"	"	"	1 1/2		
17	29	"	"	"	1 1/2		
18	24	"	"	"	1 1/2		Delayed union.
19	39	"	"	99th St.	1 1/2		
20	70	"	"	Bellevue.	...		No union.
21	44	Compound.	"	"	2	Bent.	
22	66	Simple.	"	"	1	Much bent.	Ankylosis.
23	50	"	"	"	1	Bent.	
24	22	"	"	"	1		Ankylosis.
25	33	"	Extracap.	"	1 1/2		
26	23	"	{ Below troch }	"	Perfect.		
27	27	"	"	"	1 1/2		{ Paralysis, abscess, etc.
28	46	"	{ Above cond. }	Park.	1 1/2		
29	51	Compound.	"	Bellevue.	1/2		
30	23	Simple.	Middle.	99th St.	...		{ Gangrene, amp., death.

It will be seen that the first table includes two cases in which serious results ensued. In Case 30 gangrene supervened on the third day after the accident, and on the second, after the dressings were applied; amputation was made, and the patient died. In Case 27 the plaster was applied on the fifth day after the accident (November 13, 1873), and removed twenty days later, when the patient found he had no sensation in the limb below the knee; the leg was also much swollen below the knee. Subsequently abscesses formed in the leg, large sloughs occurred, and the calcaneum became carious.

Both of the preceding cases are reported at more length in the number of the *New York Medical Journal* for August, 1874.

Cases treated by myself, by my own and Buck's Methods.

No.	Age.	Character of fracture.	Point of fracture.	Hospital.	Amount of shortening.	Deform'y.	Remarks.
	Yrs.				Inches.		
1	2	Simple.	Middle.	Bellevue.	Perfect.	Straight.	
2	6	"	"	"	"	"	
3	4	"	"	Private.	"	"	
4	6	"	"	"	Perfect.	"	
5	10	"	"	Bellevue.	"	"	
6	9	"	"	"	"	"	
7	15	"	"	"	"	"	
8	5	Compound.	"	"	Perfect.	"	
9	18	Simple.	"	"	"	"	
10	33	"	"	"	"	"	
11	20	"	"	"	"	"	
12	50	"	"	"	"	"	
13	35	"	"	Long Is. C.	"	"	
14	60	"	Intracap.	Park.	"	"	
15	50	"	Extracap.	"	1	"	
16	40	"	"	Bellevue.	"	"	
17	40	"	"	"	1	"	
18	35	"	"	"	"	"	
19	40	"	"	"	"	"	
20	60	"	"	Long Is. C.	"	"	Toes everted.
21	45	"	"	Private.	"	"	" "
22	70	"	Neck.	"	"	"	" "
23	40	"	Above knee.	Bellevue.	Lengthened.	"	
24	22	"	Middle.	"	.....	"	Delayed union.

These two constitute the only examples of serious accidents which might possibly have been due to the mode of dressing, in the table of 30 cases, which, as has already been explained, were recorded without selection; but they are not all which have come under the writer's notice. In one case at Bellevue an enormous perineal slough was caused by the pressure of the plaster. In addition, also, to the case of gangrene and death included in the first of the preceding tables, the following have to be recorded:

Lizzie Gibbons, *æt.* 24, fell upon the sidewalk and broke her thigh about six inches above the knee-joint. She was carried to Bellevue Hospital, and on the same day, under the influence of ether, and with limb extended by pulleys, plaster dressings were applied. Twenty-four hours later the toes looked dark, and the splint was opened about the foot. On the following morning the house surgeon found the limb cold, and sensation greatly impaired. The dressings were at once opened freely. Death took place on the third day.

Charles Grim, *æt.* 62, admitted to Bellevue Jan. 2, 1871, with a fracture of the cervix femoris, which had just occurred from a fall on the ice. On the fourth day plaster of Paris was applied with the aid of ether and pulleys. Two days later the record reads: "Patient has a large sore on sacrum, extending almost to the loins; splint taken off; extremities cold and blue; pulse felt with difficulty; suffering from some

dyspnoea; lungs emphysematous, and old fracture (?) somewhere; this P. M. he died."<sup>1</sup>

The two following cases deserve to be mentioned in this connection, inasmuch as the class of casualties to which they belong are chiefly incidental to the plaster-of-Paris method. In no other form of dressing have anaesthetics been employed so universally.

John Stockander was admitted to Bellevue August 2, 1872, with a fracture of the left femur below the trochanter. Buck's extension was applied at first, and on the eighteenth day the patient was placed under the influence of ether, the pulleys attached, and the application of the plaster commenced. The breathing was soon observed to be gasping. Ether was withheld a few minutes, when, as the breathing became regular, it was resumed. Soon after the pupils rapidly dilated, the breathing ceased, and in a few minutes more, in spite of every effort to resuscitate him, death supervened. There is every evidence to sustain the opinion that the ether was given carefully and in the usual manner.<sup>2</sup>

In the case of Mary Shules, No. 11 of the second table, ether was administered for the purpose of applying plaster; and while extension with pulleys was employed, and the bandages were being applied, "she suddenly ceased to breathe, and her face became purple." By prompt resort to various expedients, including Marshal Hall's method, Sylvester's method, and electricity, she was rescued. "Dr. Figaro thinks her respiration was completely suspended two or three minutes."<sup>3</sup> The attempt to apply plaster was then abandoned, and Buck's extension substituted, with the result of giving her a limb shortened only three-eighths of an inch.

I shall hereafter mention another case of gangrene caused by the plaster dressing, in connection with fractures of the femur in children.

Billroth has noticed the greater frequency of non-union under the plaster-of-Paris treatment; and my own attention has been called repeatedly to these cases.

T. B., a laboring man, *æt.* 60, fell Oct. 25, 1875, breaking his right femur near its middle. On the following day, with pulleys, the leg was extended until it was said to be as long as the other, and then the plaster-of-Paris splint applied. He left his bed, and was allowed to go about on crutches at the end of one week, as recommended by the advocates of this method. The apparatus was removed at the end of six weeks, when the limb was crooked, and, as the man thought, not united. The surgeon did not, however, recognize the failure to unite until some time later.

This man consulted me about seven months after the accident. I found only fibrous union of the fragments, the limb being bowed out at the point of fracture, and perfectly useless.

<sup>1</sup> A Comparison of the Results of Treatment of 308 Cases of Fracture of the Femur, etc., Bellevue Hospital, by Frederick E. Hyde, M.D., New York. New York Med. Journ., October, 1874, p. 368.

<sup>2</sup> Death from Ether, by W. B. Dunning, M.D., Acting House Surgeon, Bellevue Hospital. New York Med. Rec., October 1, 1872.

<sup>3</sup> New York Med. Journ., August, 1874, p. 134.

In July, 1875, Dr. Glass, House Surgeon, called my attention to a similar case which had been treated in Bellevue Hospital.

A danger in the use of plaster of Paris as a dressing for compound fracture of the femur has not hitherto been mentioned, namely, that in case of a secondary hæmorrhage from the femoral artery, it would be impossible to compress the artery over the pubes, in Scarpa's space, or at any other suitable point, and the patient might die before succor could be given. In cases of compound fracture of the femur, from gunshot injuries, such secondary hæmorrhages are not very uncommon; and such a hæmorrhage has occurred when the femur has been broken very obliquely, and thrust through the flesh, and has in its course so contused the femoral artery, or has passed so near to it as to have caused a subsequent sloughing of the artery.

I do not see how one is to provide for such a possible accident; since a fenestra opposite the wound would not give space sufficient to secure the bleeding vessel; and a sufficient fenestra over the groin might so much weaken the splint as to render it of little or no value. The accident has occurred, and may occur again; the surgeon ought, therefore, in case he uses the plaster after a compound fracture, so far as possible, to provide an opening sufficient for a free approach to the upper portion of the femoral artery, in order that pressure could be applied and the bleeding controlled until the vessel was secured.

In no other limb than the thigh is this danger so imminent, for the reason that nowhere else are the vessels which are liable to rupture so large.

It has been almost the constant practice of late, in this country, to employ ether and the pulleys while applying the plaster, and this is considered one of the great essentials to success. It is proper, then, to put into the account, as against this method, the danger from anaesthetics; and to inquire, perhaps, whether the usual danger attending the exhibition of these agents is not increased by the condition of forced decubitus, and of extension to which the patients are subjected while the plaster is being applied.

A case reported to the South Carolina State Medical Association, in 1874, by Dr. Robert W. Gibbes, of Columbia, S. C., furnishes the first opportunity yet presented to me to observe in the autopsy the result of treatment in a case in which plaster of Paris has been employed according to the method just described. Dr. Gibbes has been kind enough to send me the specimen, and also photographs, from which the accompanying woodcuts were made.

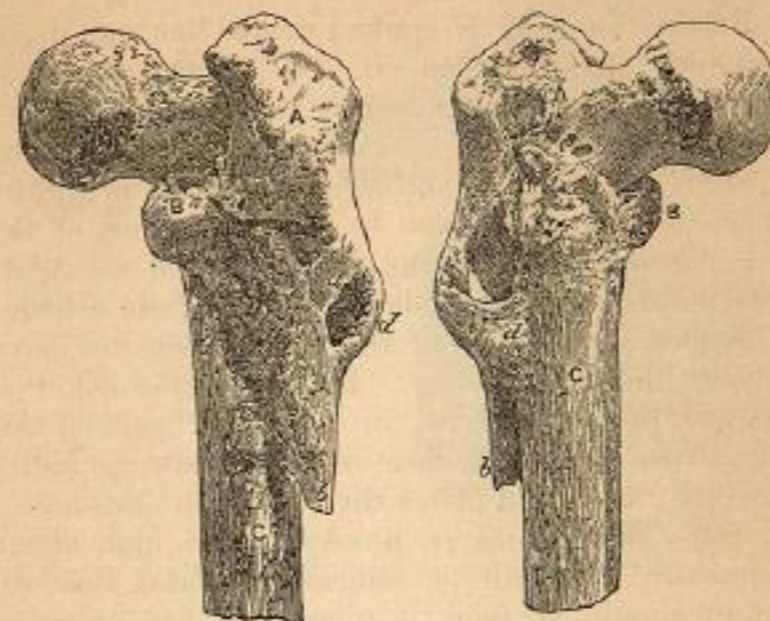
Mr. J. H. W., æt. 83, weighing 165 pounds, enjoying robust health, fell eighteen feet, January 2, 1873, striking, as he thinks, upon the right hip. Dr. Gibbes was called and detected a fracture of the right femur just below the trochanters. Fifteen hours after the accident, Dr. Gibbes, assisted by other surgeons, applied "the plaster-of-Paris dressing after the well-known method in vogue for several years past in Bellevue Hospital, my venerable patient being kept for some time suspended above the table and fully under chloroform."

On the fourth day he made an attempt to walk, but the attempt was not resumed until about the eighteenth day, after which "he began to

walk around his room daily." The apparatus was removed on the forty-third day. The union was firm, and the limb appeared to be shortened three-quarters of an inch, as determined by several careful measurements. On the 29th of June, about six months after the accident, he died of apoplexy. At the autopsy it was found that the femur was broken just below the trochanters into three fragments.

FIG. 184.

FIG. 185.



Dr. Gibbes's case.

Posterior view.

Anterior view.

A, B, C, three fragments; d, bony bridge.

The result of the treatment, considering his age and weight, was all that could have been expected; and the preference given to the plaster in this particular case was judicious; but the point to which I desire to direct the attention of the reader is, that the specimen does not sustain the claim made by certain advocates of this method, that it is able to prevent a shortening in all cases. In this case there is, according to the measurements made before death, a shortening of three-quarters of an inch. An examination of the specimen convinces me that it is somewhat more; but however this may be, one thing is certain, the limb shortened to the same degree that it would have done if no apparatus whatever had been employed. It shortened until the upper end of the lower fragment struck and was arrested by the neck. The apparatus enabled the patient to walk sooner than he could otherwise have done; and this is a consideration of more importance often in an old man than the length or form of the limb, and I doubt whether any other plan would have made the limb in this case any longer.

Dr. John T. Hodgen, of St. Louis, in a paper on the "Value of Extension in the Treatment of Fractures of the Femur," and especially as effected by his mode of suspension, speaks of the attempt to accomplish this by a plaster-of-Paris splint, as a proposition too absurd to deserve

serious consideration; and in justification of this statement he has given several unanswerable anatomical and surgical facts.<sup>1</sup>

It will be necessary to describe a little more in detail than has been done in the chapter devoted to the general consideration of fractures, the method of applying the plaster of Paris in fractures of the thigh, which was formerly adopted at Bellevue. I say "formerly," because I have not seen it employed in any recent case at Bellevue during the last two years. Certainly if it has been employed, the practice is very exceptional.

A plaster-of-Paris bandage is applied to the foot and leg some hours before the complete dressing is made. It is better that this should be done twelve or twenty-four hours before, in order that this portion of the apparatus may become solid, and not remain liable to be indented, or pressed inwards toward the limb when extension is applied, and also in order that the surgeon may know by an examination of the toes after the lapse of a sufficient time that the dressing is not too tight.

This section of the apparatus should extend from a little above the metatarso-phalangeal articulation of the toes to about the junction of the middle and lower thirds of the leg. Instead of the soft woollen cloth, which is generally to be preferred in the upper part of the limb, we may here lay next to the skin a sheet of cotton-batting, and this should be thicker over the instep and above the heel than elsewhere. We cannot take too many precautions in protecting the limb about the ankle from undue pressure. It will be remembered, also, that while at the ankle the splint should be thick, composed of five or six consecutive turns of the roller, it may be light upon the foot, and near the upper end of the splint upon the leg.

While the dressings are being applied, and until they have hardened, the foot must be held carefully at a right angle with the leg, and in a proper line as to inversion or eversion; but the assistant must take care that he does not, with his hand or fingers, indent the plaster.

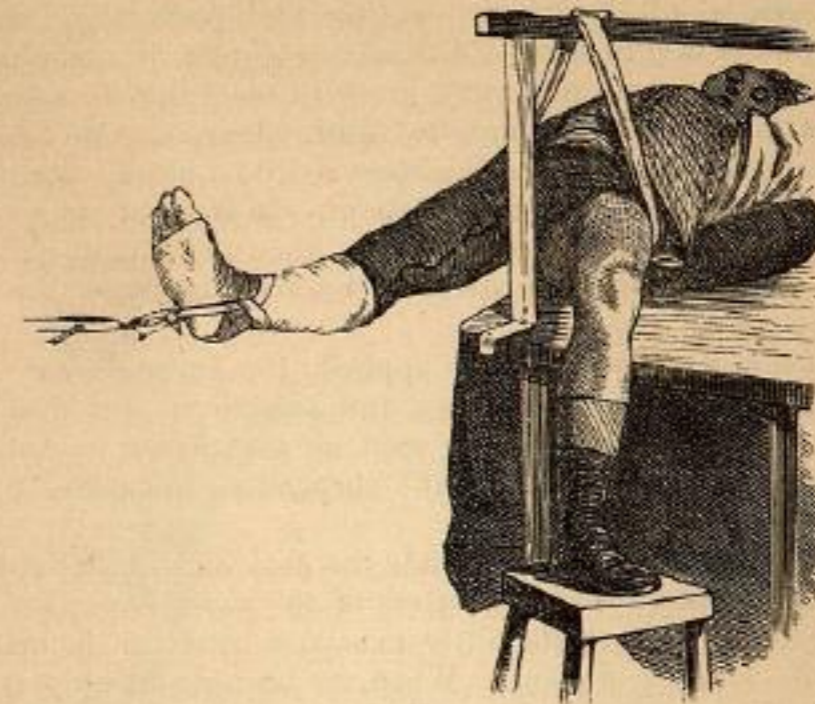
A temporary congestion of the toes almost always ensues upon the application of the bandage, but this usually subsides within twenty-four hours. If it does not, the bandage is too tight, and must be cut open.

In applying the final dressings on the following day, or when the first dressing has become solid, the patient is laid upon a bed composed of two or three mattresses, or of a sufficient number of folded blankets, his loins, shoulders, and head resting upon the bed thus constructed, while his hips, thighs, and legs extend beyond the bed. In order to support the lower portion of the body in this position a piece of a cotton roller, three inches wide and two yards long, having been lubricated with sweet oil, is passed under the pelvis, and tied above to a bar supported by a stanchion, as seen in the woodcut (Fig. 186). Various methods of supporting the pelvis have been devised, but this is the most simple and efficacious. The piece of bandage is directed to be softened with oil, in order that it may be easily withdrawn when the dressing is hard; but if it has not formed a cord this may not be necessary, and it is sometimes cut off and left inclosed with the splint.

Hodgen, St. Louis Med. and Surg. Journ., April, 1878.

The iron stanchion, wrapped with woollen cloth, is now brought against the perineum, and the pulleys made fast to the foot by a noose of cotton bandage. Moderate extension is made, sufficient to support and steady the limb, but not sufficient to overcome the shortening.

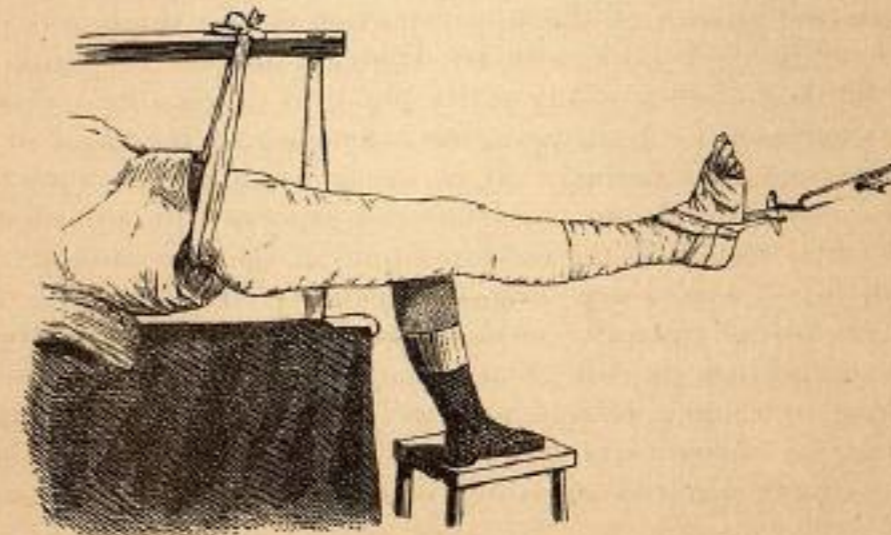
FIG. 186.



Extension during application of plaster of Paris.

The surgeon now wraps the limb, including the pelvis, thigh, and leg, down to the first splint, with soft but coarse woollen cloth, cutting out

FIG. 187.



Extension continued until the plaster is hard.

portions here and there, and fitting it smoothly to all the irregularities of surface, and stitching it loosely, when it is in place, over the region of the tuberosity of the ischium and perineum. Where the splint is liable

to make undue pressure, two or three thicknesses of cloth may be placed, or cotton-batting may be used instead.

Everything being ready, the assistant places the patient completely under the influence of an anæsthetic, and then extension is made with the pulleys until the limb is restored, if possible, to the same length as the other.

The bandages, filled with dry plaster, and previously soaked a few minutes in water, are then applied from below upwards, including, finally, the pelvis as high as the loins. At no point must they be drawn tightly, but only with sufficient firmness to insure their accurate adaptation to the limb. Three, four, or five thicknesses are required, according to the size of the limb, or the age of the patient. In front of the groin, where the splint is most liable to become broken when the patient gets up, there should be laid two or three strips of binder's board, or narrow metal strips, tin or zinc.

After each successive layer is applied, the surgeon will sprinkle a little dry powder upon the surface, and smooth it over with his hand previously dipped in water. As soon as the plaster is hard, usually within twenty or thirty minutes, the suspending apparatus is removed, and the patient placed in bed.

Those surgeons who omit to include the foot and ankle in the plaster splint do not, I think, avail themselves of the most important and most reliable means of making the little extension that can be made permanently in this form of dressing. When the limb shrinks, the condyles of the femur and the calf of the leg offer very imperfect or no resistance to the action of the muscles of the thigh, and extension is completely lost. Let it be understood, also, that the author does not recommend that the perineum shall be made the point of counter-extension; and in this he is sustained by the majority of those who have used this dressing; and the shrinkage of the muscles of the thigh, which soon ensues, renders it equally impossible, ordinarily, to maintain permanently, against the only slightly conical surface of the upper portion of the thigh, any effective counter-extension. I think, with Dr. Hodgen, that the proposition is absurd, and I do not see how any really practical surgeon can entertain it.

The patient can, in most cases, leave his bed by the third or fourth day after the splint is applied. If he keeps out of bed the limb will not shrink as much, and the necessity for readjustment will less often arise. But he cannot remain in the erect position all the time, and at the best there will be, as experience shows, opportunity enough for the limb to shrink, and for the apparatus to become loose. In case it becomes loose it cannot be refitted by cutting out a portion and folding the splint in again, since it is too inflexible, and will not be made to bear upon the same points as before. At Bellevue, when a plaster dressing becomes loose it is always removed and a new one applied in the same manner as at first.

Finally, having considered somewhat at length the leading plans of treatment which have, from time to time, been suggested and employed by our best surgeons both at home and abroad, I desire to describe in greater detail those methods and forms of apparatus which my own experience has taught me to prefer.

As to posture, my opinions are in accord with the opinions of a vast majority of the most experienced surgeons of the present day. The straight position will, on the average, give the best results. Careful measurements made by myself in several hundreds of cases, a portion of which have been published in my statistical tables,<sup>1</sup> have demonstrated that the average shortening of the limb is greater after any method of treatment in which the flexed position is employed, than after treatment with extension in the straight position. Whether this statement ought to include broken femurs treated by Dr. Hodgen's method I cannot say, since I have not measured many limbs treated by his method, and he

FIG. 188.



Badly united fracture of the femur; treated without permanent extension.

FIG. 189.



Fracture of femur just below trochanter minor.

has not given to the profession any exact statistical record of his own results. I must, however, state my conviction that the average results of these cases will fall a good deal short of the average results obtained, when proper extension is employed, in the straight position. These same carefully recorded observations, and my later observations, have also shown that the flexed position, contrary to the reiterated statements of most of its advocates, is more apt to entail angular deformity. Fig. 188 is a fair illustration of what I have seen occur more than once when

<sup>1</sup> Fracture Tables, by F. H. Hamilton, 1853.

the flexed position has been adopted; a condition which is impossible when proper extension is employed in the straight position.

There are a few who, rejecting the flexed position in fractures of the middle of the shaft, still declare for this position a preference when the fracture occurs just below the trochanters, and in the case of fractures at the base of the condyles.

According to Malgaigne, who has devoted especial study to this subject, there is no satisfactory evidence in favor of the flexed position when the fracture occurs below the trochanters. It is not directly forwards, but forwards and outwards, that the lower end of the upper fragment is carried by the action of the *psoas magnus* and *iliacus internus*; so that in order to meet the supposed indication it would be necessary to carry the lower part of the limb outwards also, a position which would certainly be found inconvenient, if not actually impracticable, in the majority of cases. Nor can the tendency of the upper fragment to advance in the forward direction, and consequently to separate from the lower, be met effectually by posture alone, unless the thigh is completely flexed upon the body. Indeed, it is apparent that the position of moderate flexion will rather favor the action of those muscles which are supposed to be chiefly responsible for the displacement. When the thigh is extended upon the body, the *psoas magnus* and *iliacus internus* are acting in the direction of, and nearly parallel to, the axis of the femur, and consequently to a disadvantage; but when the limb is lifted, their action is more nearly at a right angle with the shaft, and their ability to displace the fragment is greatly increased.

Moreover, it ought to be understood that broken bones are seldom or never displaced or separated, in the same manner they would be if they were not surrounded with many other structures which have suffered little or no disruption: they pass each other, but do not separate widely, being held together by shreds of periosteum, muscles, tendons, ligaments, etc. The same happens when this bone is broken just below the trochanters; the upper fragment lies always, or almost always, in immediate contact with the lower, and whatever force is brought to bear upon the lower fragment more or less directly influences the upper; we can then by extension applied to the leg, draw down not only the lower fragment, but we can drag into line the upper fragment. No doubt in this attempt we shall meet with some resistance from the muscles above named; but experience has always shown that even moderate extension, applied steadily and without interruption, seldom or never fails to overcome, in a great measure, the resistance of the most powerful muscles. We constantly avail ourselves of this principle in overcoming the abnormal contraction of muscles in connection with diseased joints, in the reduction of old dislocations, and in many other ways.

Whatever the advocates of flexion in fractures of the femur may say to the contrary, they are never able in this position to employ effective extension and counter-extension. A careful examination of all the double-inclined planes which have been devised, including Nathan R. Smith's and Dr. Hodgen's suspending apparatus—I say it with all respect for these distinguished surgeons—it appears to me, ought to convince any experienced observer that such is the fact. Whatever

other excellences they may possess, this does not belong to them. But extension is, of all the indications of treatment, that which is of the greatest importance in nearly all fractures of the thigh, and no less important in the upper third than in the lower. Indeed, it is of more importance in case of a fracture through the upper than in the case of a fracture through the lower third, since, as my measurements have shown, the higher the point of fracture the greater is the tendency to shorten, in consequence of the action of those powerful muscles which, arising above, have their insertions into the lower fragment.

In the case of all those double-inclined planes where the body rests upon a bed, there can be no counter-extension except the weight of the pelvis and its contents. It will not do to fasten the pelvis to the bed by bands, as every one who chose to make the experiment would soon learn; nor will the groin tolerate the pressure of counter-extending splints or bands. These things have been tried in a thousand ways, and abandoned. The weight of the pelvis alone, not of the entire body, is the only counter-extending force which can be made available in these forms of apparatus, and this is wholly insufficient. In Nathan R. Smith's anterior suspension splint, not even the weight of the pelvis is employed as a means of counter-extension, the pelvis being secured to the splint by rollers, equally with the thigh and leg, and there is no possible chance for extension and counter-extension.

After all, I prefer to leave this question to the verdict of experience, and happily this seems to be conclusive, if we may accept the almost unanimous testimony of those surgeons who have enjoyed the largest hospital practice. In my own experience the ordinary double-inclined planes have constantly given the worst results, both in regard to length and lateral displacement; they are the most difficult to manage, and are the most fatiguing to the patients. Nathan R. Smith's suspending apparatus permits the limb to shorten indefinitely; and it affords inadequate support along the centre of the shaft, in consequence of which the limb is apt to unite with a backward curvature or angle. In some gunshot fractures treated by this apparatus this posterior curve or angle has been excessive.

Even the old methods of extension were preferable to flexion; but they had always two serious drawbacks. First, in the excoriations and ulcerations incident to the application of extending bands or gaiters, or whatever else was employed for this purpose. Again and again I have seen ulceration of the instep, of the integuments above the heel, and of other parts of the foot and ankle, from extending bands. And, second, from similar excoriations, ulcerations, and deep sloughs about the groin and perineum, caused by the counter-extending band. It is true these accidents did not occur often, and sometimes they were due wholly to negligence; but, in order to avoid them, we were compelled to limit very much the amount of extension, and to exercise unceasing vigilance. At Bellevue, as I have elsewhere reported, an attempt was made to employ counter-extension in the perineum of an adult, by plaster of Paris applied in the usual manner for a broken femur, and as a consequence a perineal slough was soon formed two or three inches in depth by several inches in length. Lente, the Burges, myself, and others sought

to overcome some of the difficulties of the perineal band by various contrivances; and perhaps in some measure we were successful, but still the danger of ulceration existed wherever much force was employed, or the integuments were unusually delicate. Gilbert's plan of substituting adhesive plasters for the usual counter-extending band, in the perineum, and Buck's plan of employing elastic tubing, possess no real advantages. The truth is, there is no point about the groin, perineum, or pelvis upon which, by one surgeon or another, the pressure has not been made, and more or less distributed, for the purpose of counter-extension; and there is no possible method, perhaps, which has not been employed; yet, after a fair trial, the results are the same. The pressure must be moderate, or serious accidents will occasionally happen.

Hodge's attempt to make the counter-extension from the sides of the trunk by strips of adhesive plaster, as already described, is wholly inefficient. They will loosen inevitably in a few hours.

Our first great step of progress in the treatment of fractures of the thigh—first in importance, but not in order of discovery—consists, then, in having secured counter-extension by the weight of the body alone, and this is accomplished by simply elevating the foot of the bed from four to six inches. I have not used a perineal band, except in cases of children, for twenty years; and, in case of children, the weight of the body is still my chief reliance. None of my colleagues at Bellevue use the perineal band to-day.

The first to suggest and practise this was Dr. James L. Vaningen, of Schenectady, New York. (We shall see hereafter that Dugas attempted to make counter-extension by the weight of the body at a still earlier period, but he did not elevate the foot of the bed.) His method was reported to me, probably, in 1855, and was published in 1857, in connection with my Report on Deformities after Fractures, in the Transactions of the American Medical Association, accompanied with three woodcuts for the purpose of illustration. The foot of the bedstead was much more elevated than has been found necessary in later experience. It is interesting to note, however, as evidence, that Dr. Vaningen had practical experience with this method, that he directed especially that the pillow should be kept under the head only, "so as to keep the neck and shoulders quite free."<sup>2</sup> According to the statements of Dr. Robert F. Weir, of this city, Dr. Buck first elevated the foot of the bed for the purpose of making counter-extension, in 1859, while Dr. Weir was an interne of the New York City Hospital.<sup>3</sup> Dr. Buck first publicly described his method in a communication to the N. Y. Academy of Medicine, in 1861.<sup>4</sup>

The second step was the employment of the weight and pulley as a means of extension. I am indebted to Dr. Martin, of Boston, for the evidence that this method of making extension was known to Hildanus, in the 16th century, although it seems to have passed very much into

<sup>1</sup> For cases of sloughing, etc., from perineal band, see N. Y. Journ. of Med., vol. xiv., 2d ser., p. 261, March, 1856; also same journal, Jan. 1840, p. 239.

<sup>2</sup> Vaningen, Trans. Am. Med. Assoc., 1857, pp. 436-7.

<sup>3</sup> Med. Record, March 9, 1878, p. 181. <sup>4</sup> Amer. Med. Times, March 30, 1861.

disuse until recently revived by American surgeons.<sup>1</sup> John Bell, in his Principles of Surgery, published at Edinburgh in 1801, speaking of a method described by Hildanus, says: "But surgeons did at last fall upon a method which absolutely insured the permanent extension. For being wearied with this perpetual turning of screws to tighten the bands around the ankle, they at last most happily thought of putting a pulley to the foot of the bed and hanging a good jack-stone to the heel. I have (in next page) drawn the bed, the surcingle or horse-girth for the body, and the jack-stone of Hildanus for hanging to the heel, and, according to my poor conception, the method of permanent extension was by this rendered so perfect that Mr. Desault could do nothing but disgrace himself by attempting any farther improvement." . . . "If this girth do not" "prevent the body from gravitating toward the fractured limb, if the jack-stone do not prevent the limb being detracted toward the body," "there must be something in the theory and practice of Mr. Desault passing all comprehension."

In the above description we see a full recognition of the value of the pulley and weight, but the body was prevented from descending by being tied to the bed, and the extension was made by a garter. We need not be surprised, therefore, that the pulley and weight under these disadvantages were soon laid aside and forgotten. Guy de Chauliac, Suetin, and Nathan Smith, according to Malgaigne,<sup>2</sup> employed occasionally the pulley and weight. Boyer says the practice is very ancient. Dr. Wm. C. Daniell, of Savannah, Georgia, treated a case in this manner in 1819, and again in 1824, the latter of which he published. The ordinary perineal band and a garter were used for counter-extension and extension.<sup>3</sup> In 1854, L. A. Dugas, of Savannah, Georgia, published an account of the method employed by himself, with an illustration.<sup>4</sup> This illustration, with a brief explanation of the mode of using the apparatus, was republished in my report to the American Medical Association in 1857, pp. 434-5, and again in the first edition of this treatise published in 1860. Dr. Buck's communication to the Academy of Medicine contains no allusion to this plan of Dugas, but in his illustrations of his own method the small cannon-ball is used as a weight precisely as in Dugas's method. I do not mention this as an evidence of unfairness on the part of Dr. Buck, but only to indicate that he had probably seen Dr. Dugas's woodcut. Dr. Buck had evidently intended to combine several improvements, for no one of which has he claimed the original conception.

Dugas used a piece of bandage as his means of applying extension; but he omitted the perineal band, which had not been done by Buck when he first made public his own method. Dugas relied upon the weight of the body to make counter-extension, saying that "the resistance of the patient's body will effect counter-extension;" a statement which later experience has shown to be not correct, unless, as first recommended by Vaningen, the foot of the bedstead is somewhat raised.

The third great step of improvement, and that which alone makes adequate extension, in most cases, possible, was the substitution of adhe-

<sup>1</sup> Martin, N. C. Med. Journ., Feb. 1878.

<sup>2</sup> Malgaigne, op. cit., p. 239.

<sup>3</sup> Daniell, Amer. Journ. Med. Sci., vol. iv, p. 330.

<sup>4</sup> Dugas, Southern Med. and Surg. Journ., Feb. 1854, p. 69.



sive strips, laid along the whole length of each side of the leg, in place of the gaiter. Of this, also, we are no longer permitted to speak as a novelty, the researches of Dr. Martin, already referred to, having brought to light the following paragraph in the works of Dr. Gooch:

"To answer the same purpose, I have confined one end of a strong strip of sticking plaster, of a suitable length and breadth, under a circular piece of the same, about the middle of the side of the foot, carrying it over the heel, up the leg, and confining the other end above the calf with another circular plaster, first, gradually bring down the musc. gastrocnem. as far as they will readily yield; giving the limb, at the same time, the position described in my treatise on wounds. On the like occasion, I have also fixed one strap by the circular about the foot, and another by that above the calf of the leg, passing the one through a slit in the other, and using them as the uniting bandages; but then two more circulars are requisite to confine the other ends of the longitudinal straps securely."<sup>1</sup>

This also, like extension by a pulley and weight, seems to have been forgotten until revived by some American surgeons. The first allusion I find to it in recent literature is by Dr. F. W. Sargent, of Philadelphia, in 1848, who says he derived the suggestion from Dr. E. Wallace, of Philadelphia, by whom they were used successfully while he was the Resident Surgeon of the Pennsylvania Hospital. Both of these gentlemen used long strips of adhesive plaster, of an inch or more in width, carrying them spirally down the leg from a point about midway between the foot and knee, after which they were, in some cases, made secure with rollers.<sup>2</sup>

In the third volume of the Transactions of the American Medical Association (1850) the same method is described as being recommended by Dr. Josiah Crosby, of New Hampshire, the only difference being that he carried the adhesive plaster as high as the knee.<sup>3</sup> In this brief notice of Dr. Crosby's plan, the editor remarks that Dr. Sargent had in his *Minor Surgery* described essentially the same, as being first practised by Dr. Wallace. Vaningen suggested the same in connection with the elevation of the foot of the bed, in 1857, as will be seen by reference to my reports, before referred to. Dr. Buck spoke of it publicly in his communication to the Academy of Medicine in 1861.

Of the claims instituted for Dr. Mosely, of New Hampshire, who says his use of these strips dates back to 1840, and the like claims of Gross, Swift, Ennis, and others, we can only say they were unfortunate in not earlier giving their views and practice to the public.

Finally, it is by the combination of these three essential principles with the short side-splints and one long side-splint, which shall reach from near the axilla to beyond the foot, to prevent the outward bowing of the thigh and to prevent eversion of the leg, that the superiority of

<sup>1</sup> "Medical and Chirurgical Observations as an Appendix to a former Publication, by Benjamin Gooch, Surgeon, London, printed for G. Robinson, in Pater Noster Row, and R. Beatniffe, in Norwich." No date, but about 1771. N. C. Med. Journ., Jan. 1878, Martin.

<sup>2</sup> *Minor Surgery*, by F. W. Sargent, M.D., Lea & Blanchard, Philadelphia, 1848.

<sup>3</sup> Crosby, *Trans. Am. Med. Asso.*, 1850, vol. iii. p. 383.

extension in the straight position can alone be demonstrated. The long outside splint, which I have myself added to the apparel, is only second in point of importance to either of the others, and that whether the fracture be in the neck or the shaft, in children or in adults. In children, however, it is supplied by the double splint.

With regard to fracture beds, which, when surgeons adopted the flexed position in the treatment of fractures of the thigh, were often very useful and sometimes necessary, I must say that, in the treatment of these fractures in the extended position, they are not needed. We never use them for this purpose at Bellevue, nor do I think they are used at any hospital in this city. If the bed is sufficiently long and the mattress is smooth, firm, and even, nothing more is required. Properly shaped bed-pans can always be used without disturbing the limb, and the arrangements for changing the position of the limb are not only useless, but such changes are actually injurious. Inasmuch, however, as in certain complicated cases of fracture of either the thigh, leg, or foot, adjustable or movable "invalid" beds may be needed, when extension is not to be attempted, I shall see fit to allude to a few of those which are best known among American surgeons.

As invalid beds, the best known and most ingenious American contrivances are those invented by Jenks,<sup>1</sup> Daniels, the Burges, Addinell

FIG. 190.

E. Daniels's invalid bed.<sup>2</sup>

Hewson, of Philadelphia,<sup>3</sup> J. Rhea Barton, B. H. Coates, of the same city,<sup>4</sup> and J. Crosby, of Manchester, N. H.<sup>5</sup>

In my earlier practice I have had constructed a simple frame, covered with a stout canvas sacking, having a hole at a point corresponding with the position of the nates, and this I have laid directly upon a common four-post bedstead. A mattress and one or two quilts must be placed

<sup>1</sup> Jenks, *Gibson's Surgery*; also the 5th ed. of this treatise, Fig. 185, p. 445.

<sup>2</sup> See also Figs. 186 and 189 of 5th ed.

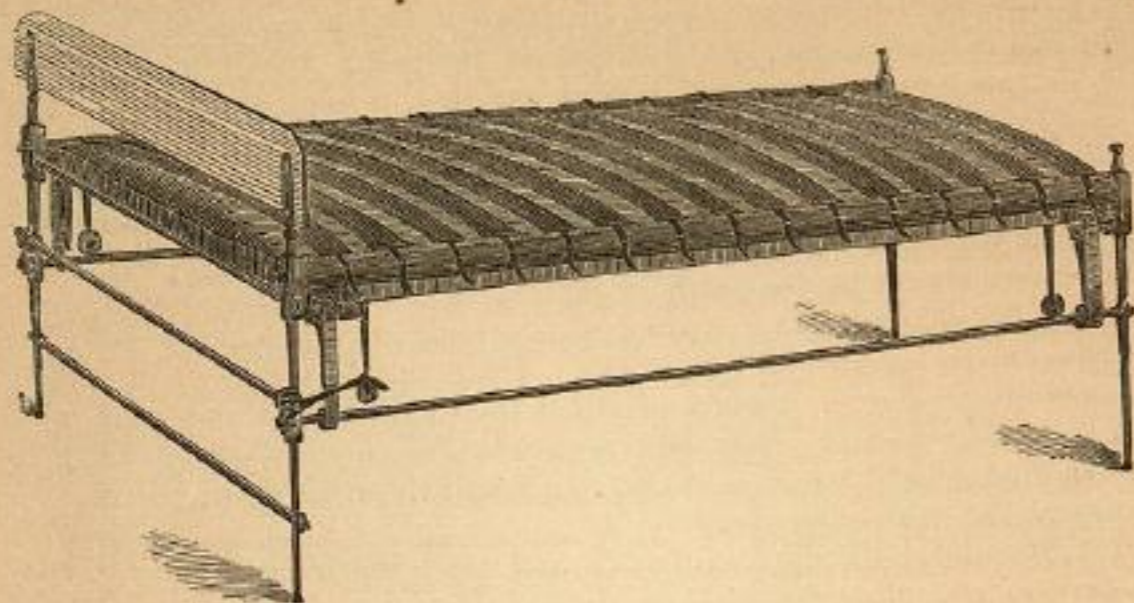
<sup>3</sup> Hewson, *Amer. Journ. Med. Sci.*, July, 1858, p. 101.

<sup>4</sup> *Eclectic Repertory*, 5th and 9th vols.

<sup>5</sup> Crosby, *Treatise on Military Surgery*, by Frank H. Hamilton, 1865, p. 413.

upon the boards of the bedstead underneath the sacking, and a sheet or two above the sacking, upon which last the patient is to be laid. In arranging the linen underneath the patient, the most convenient plan is,

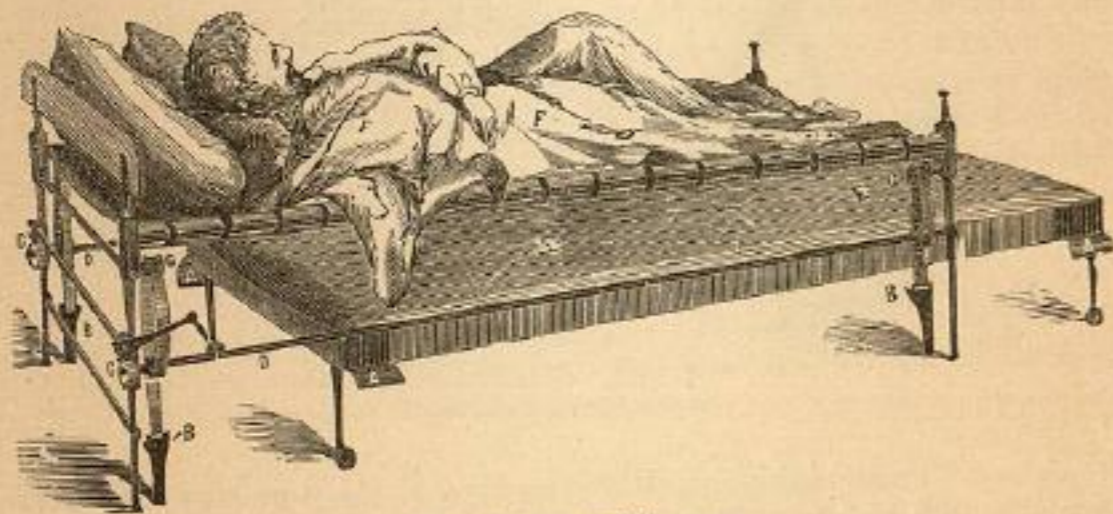
FIG. 191.



Crosby's invalid bed, closed.

instead of using only one sheet, which will require that a hole shall be made in it corresponding to the hole in the sacking, to employ two sheets, and, doubling them separately, to bring the folded margin of each from

FIG. 192.



Crosby's invalid bed, open.

The bed is movable, and can be run out from under the patient and changed. It is then run back, the hooks *B* being made fast to the catches *A*. By turning a crank at *C*, the rail *D* is revolved, which winds up a strap passing over the pulley *G*, and the bed is raised to its position, thus taking off the weight of the patient from the bands by which he was temporarily suspended.

above and from below to the centre of the opening. When the patient has occasion to use the bed-pan, it is only necessary that two or four persons should lift this frame, and place under each corner a block about

one foot in height, or it may be raised by a pulley and ropes suspended from the ceiling.

My usual practice now, in a private house, is to remove the foot-board and lengthen the bed by boards laid longitudinally, and projecting one or two feet beyond the bottom rail. This furnishes a firm support for the mattress. Sometimes, of course, it will be found necessary to lengthen the bed. No hole is made in the flooring of the bed or of the mattress, to provide for fecal evacuations.

A very comfortable bed, especially for children, can sometimes be made from a cot. But it will be necessary always to nail a piece of board firmly across the top and bottom of the bedstead when the sacking is at its utmost tension, in order to prevent the side rails from falling together. The top board must be nailed on vertically, like an ordinary head-board, so as to prevent the pillows from falling off, but the bottom piece, at least one foot wide, should be laid horizontally to support and steady the apparatus as it extends beyond the foot.

Having had occasion to assist the late Dr. Treat in the management of a fracture of the thigh in the case of a little girl not quite three years old, I was struck with the simplicity and completeness of an arrangement which he had made to prevent the bed and the dressings from becoming soiled with the urine. It was only to leave directly underneath the nates a complete opening through to the floor for the escape of the urine, and to protect the margins of the sacking and sheets, which came nearly together at the opening, with pieces of oiled cloth folded upon themselves. It was found that not only the bed was in this way kept dry, but the dressings also; it being now observed that the dressings had become wet heretofore by soaking up the moisture from the bed, rather than by the direct fall of the urine upon them.

Having prepared the bed for the reception of the patient, and elevated its lower end about four inches by placing blocks underneath the foot-posts, the following additional preparations should be made before we proceed to reduce the fracture and dress the limb:

There should be provided a piece of board of the requisite length and breadth, furnished with a slot to receive the pulley, and called the "standard," a small iron rod, a pulley, a yard of rope, and a vessel or bag to receive the weights.

The slot should have sufficient length, and the standard should be perforated in the direction of its breadth at short distances, to enable the surgeon to elevate or depress the pulley, as may be required. In case a metallic pulley cannot be obtained, a spool will answer as a tolerable substitute. We now employ generally, at Bellevue, an iron upright rod, with a pulley affixed, and which is made fast to the iron frame of the bedstead with two iron clamps, secured in place by screws. They may be found at the shops of any of our instrument makers. A pulley, mounted with a screw, may be sometimes substituted, the screw being attached to the foot-board. (Fig. 194.)

The adhesive plaster which I have generally used both in private and

FIG. 193.

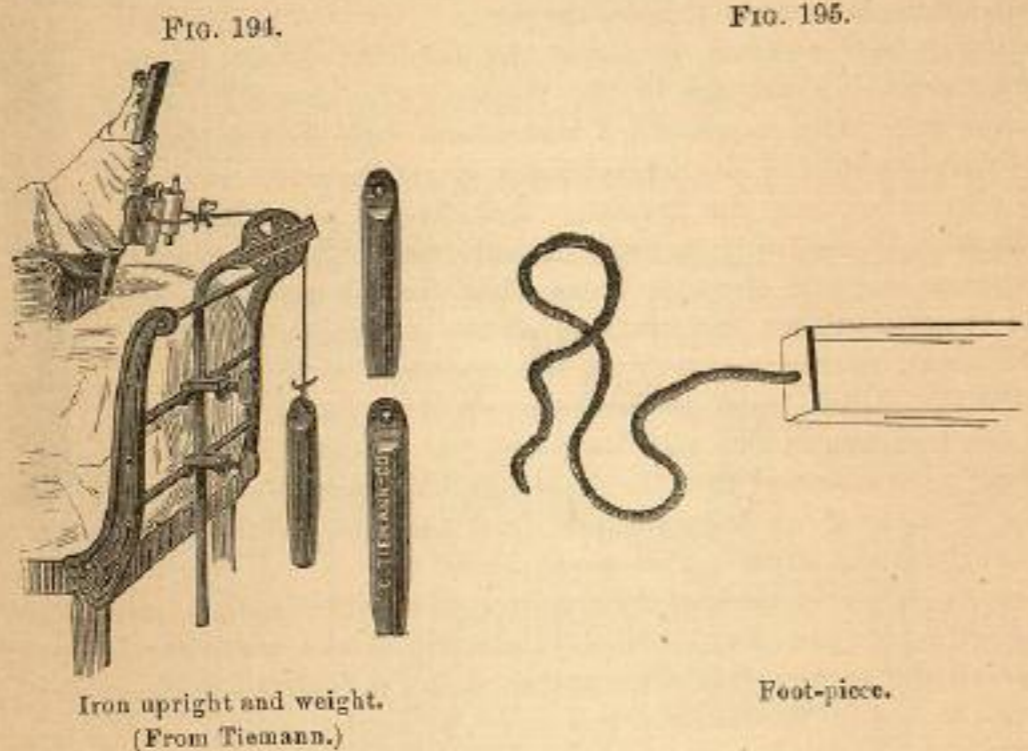


Standard.

hospital practice is that which is usually found in drug stores, spread upon linen; but some of my colleagues prefer the plaster spread upon jeans or canton flannel, as being stronger. I cannot, however, appreciate their advantage, since the ordinary plaster seldom gives way when properly applied. Dr. John B. Brooke, of Reading, Pa., prefers the "ordinary pitch plaster," as being "elastic, soft, and firmly adherent," and as not excoriating, etc.

A thin block or piece of board, called the "foot-piece," is to be provided, perforated in the centre to receive the cord, and of sufficient length to prevent the adhesive strips or "extension bands" from pressing upon the malleoli. An average size for the foot-piece in the case of an adult is about three inches and three-quarters in length, by two and a half in breadth.

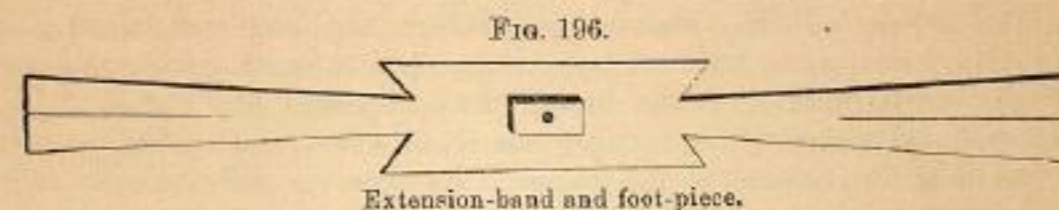
The adhesive plaster may be cut in the shape shown in the illustration (Fig. 196): five and a half inches wide in the centre, and two and a half



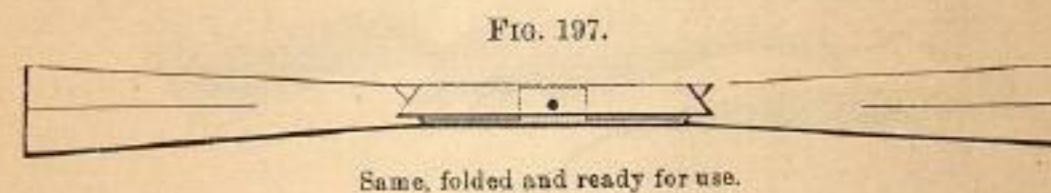
inches wide at the narrowest point, and gradually widening again toward each extremity to four inches; the narrower portions being slit down two-thirds of their length. For an adult we generally require a strip of about four feet and eight inches in length, namely, sixteen inches for the central and widest portion, and twenty inches for each extremity. The shoulders of the central portion are cut as represented, in order that when folded upon the foot-piece and upon itself it may reinforce the lateral bands at their weakest points.

The lateral or side-splints may be made of thick pieces of gum-shellac cloth, of stout leather cut and moulded to the limb, or of thin pieces of board covered with cotton cloth and stuffed on the sides next to the skin with cotton-batting to fit all the inequalities of the limb. Of these several materials gum-shellac cloth is much the best. It is thin, light, firm, and after immersion in hot water can be sufficiently moulded to the

contour of the thigh. The cotton cloth must be stitched over the splints like a sac, but left open at the ends until the padding is properly adjusted. Loose cotton-batting always becomes displaced. Four splints are generally required: one for the anterior surface, extending from the groin below the anterior inferior spinous process of the ilium to within half an inch of the patella; one for the posterior surface, extending from the tuberosity of the ischium to a point six or eight inches below the knee; one for the inside, extending from near the perineum to the inner condyle; and one for the outside extending from above the trochanter major to the outer condyle. These splints ought to encircle the limb almost completely, only leaving an interval of from half an inch to one inch between each of the adjacent splints. The outer and inner splints may be extended below the knee when the fracture is low down; but in



that case they must be carefully fitted to the irregularities of the condyles. The posterior splint is the most important of them all. It should be wider and much longer than either of the other splints, and it must be fitted with great accuracy to the back of the thigh, ham, and upper



part of the leg. It is important also to cover this with a sac of cotton cloth so that it may be stitched to the centre of the bands, which are to inclose all the splints. If this is not done, it is very liable to become displaced.

A long side-splint must now be prepared, long enough to extend from about four inches below the axilla to five inches below the heel; four and a half inches wide, by half an inch in thickness, and provided with a cross-piece at the lower end, two feet long by three inches wide and half an inch thick. The purpose of this splint is not to make extension, but to prevent the femur from becoming bent outwards at the seat of fracture; which is accomplished more certainly by this splint than by the short splints, inasmuch as it keeps the whole body, including the upper part of the femur, in a straight line. Its purpose is also to prevent eversion of the foot, which purpose is never accomplished effectively by junks or by any other method I have yet seen adopted. It is to be employed in all fractures of the thigh, including fractures of the neck. The inner surface of this long splint must be padded throughout its whole length, and thus fitted accurately to the sides of the body and limb.

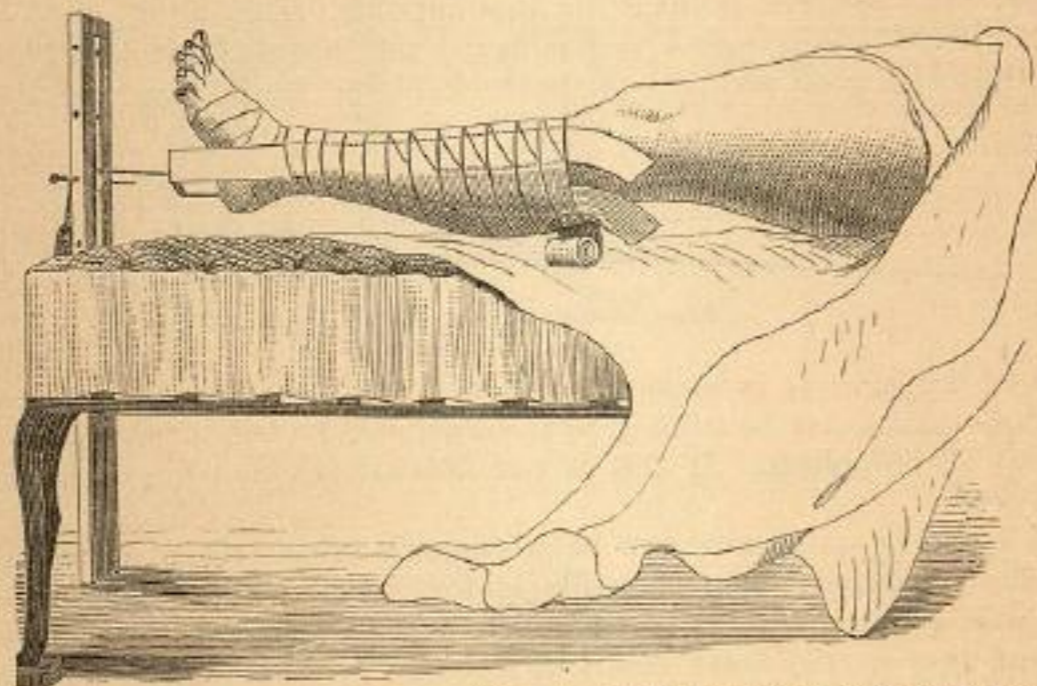
Four or six strips of cotton cloth, each two inches wide by one yard

in length, are stitched by their centres to the back of the posterior splint, and these are laid upon the bed in position to receive the limb.

Supplied with rollers, several additional strips of bandage, and cotton-batting, we are now ready to reduce and dress the fracture.

The patient being placed in position upon the bed, one assistant seizes the limb by the knee, and a second by the foot, drawing upon it firmly and steadily, at the same moment lifting it from the bed so as to render it more accessible; while the surgeon lays the extremities of the extension strip upon each side of the leg, with the centre, containing the foot-piece and the rope, about one inch below the sole of the foot. With a muslin roller, inclosing the limb from near the metatarso-phalangeal articulation to the tuberosity of the tibia, the adhesive strips are held in place. As a rule, and especially in the case of women, and of persons of a delicate lax fibre, it is well to lay against the tendo Achillis, and over the instep, a little cotton-batting before applying the roller. In some cases I am in the habit of applying a thin sheet of cotton-wadding over the whole surface of the limb. Any excess of the bands at the upper end is disposed of by turning the ends down, and inclosing them in a few additional turns of the roller. As soon as the application of

FIG. 198.



Mode of applying adhesive plaster. (When the dressings are completed, the limb is to rest on the bed.)

the adhesive strip and roller is completed, the weight may be adjusted, and extension applied. The amount of extension required for adults will vary from eighteen to twenty-three pounds. In a large proportion of cases, twenty or twenty-one pounds will be borne without complaint; and the ability of the patient to tolerate the extension, alone limits the amount. Occasionally, even a few pounds, when first applied, cause pain in the ligaments about the knee-joint; but in a few hours the amount may be increased. It is better to apply eighteen or twenty

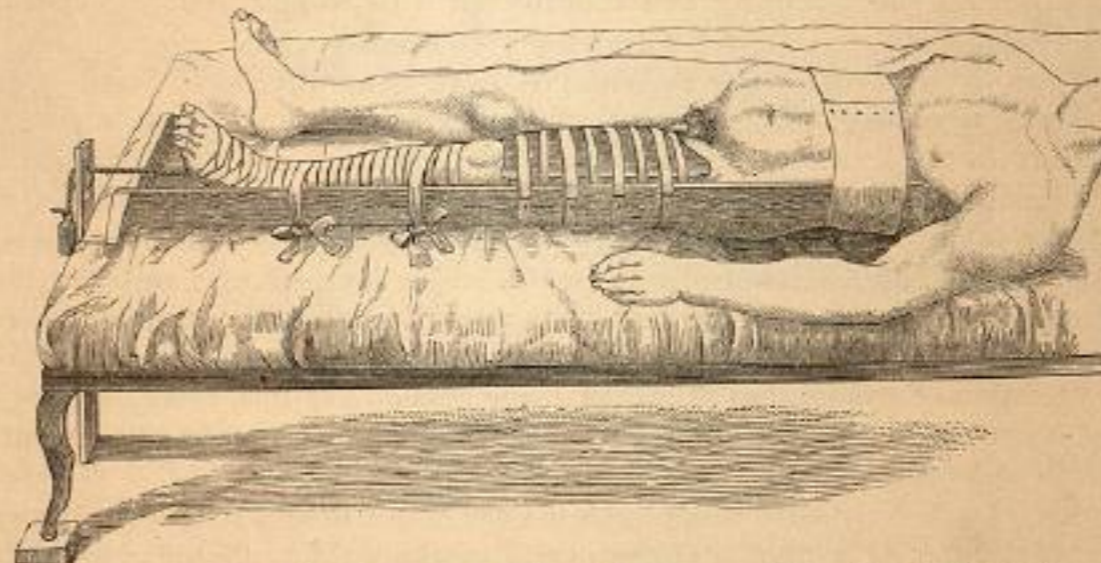
pounds at once, if it can be borne. Lifting the knee slightly by a pad placed underneath will often relieve the pain caused by the extension.

Sometimes, in the case of very muscular patients, and where the primary shortening is considerable, I believe we make a positive and permanent gain if we place the patient under the influence of chloroform for a few minutes when the weight is first applied. In these cases, as in dislocations, I generally prefer chloroform to ether, for the reason that the patient is less liable to muscular contractions when he is passing under the influence of the anaesthetic.

Extension being effected, and the patient already resting upon the posterior coaptation splint, the three other side-splints are applied, and the whole four secured in place by the four or six transverse bands already described as attached to the posterior splint; the bands being tied over the front splint firmly.

It remains only to lay the long splint beside the body, and to secure it in place by separate strips of bandage. Three strips for the leg, one broad strip for the pelvis, and one for the chest, are all that are required. The leg strips may be drawn pretty firmly to prevent all outward rotation of the limb. The pelvic band also ought to be tight enough to insure the constant contact of the pelvis with the long splint; but the thoracic band may be rather loose, as its function in this respect is not so important. One broad band may be substituted for the two latter, which should be sewed to the cover of the long splints to prevent its becoming displaced. In the drawing (Fig. 199), narrow strips inclose the thigh and long splint, but I often omit them as being unnecessary; indeed, it is better sometimes to omit them when the fracture is high up, lest they should

FIG. 199.



Author's dressings for fracture of shaft of femur, complete. (The long splint extends nearly to the axilla.)

hold the lower fragment out, when the pelvis was not firmly secured to the long splint; in which case the other fragment might incline in the opposite direction, causing thus a bowing out at the point of fracture.

The patient's pillow must rest under the head alone, in order that the

whole weight of the body, from the shoulders down, may be employed as a means of counter-extension. Omission of this important precept will sometimes permit the body of the patient to descend toward the foot of the bed, even when the foot of the bedstead is raised.

During the first four or five weeks the patients should not be allowed to rise or to sit up in bed. It is an error to suppose that such restraint is irksome. In my experience, no patient has ever complained of it; and I have no doubt that such movements increase the danger of non-union; a misfortune which has never happened when a patient has been under my treatment from the first to the last. I have, however, seen several cases of non-union, or of delayed union, in the practice of other surgeons, which I attributed to the patient having been permitted to rise in bed. For this reason, also, I reject all modes of treatment which are intended to permit these motions of the body, such as Burges's fracture-bed.

In order to evacuate the bowels, the patient may draw up the sound limb, when a properly constructed bed-pan is easily placed under the nates. This occasions no disturbance to the fracture.

From the time of the first dressing the patient should be seen daily, and the coaptation splints loosened or tightened from time to time, as may seem necessary. To open the limb, and even to remove temporarily all the coaptation splints except the posterior one, is harmless, and it is often a source of comfort to the patient. Ordinarily it is not necessary or prudent to disturb the extension until the union is completed. The usual time required for consolidation in the case of an adult is from six to eight weeks; but if the bone feels pretty firm at the end of four weeks, the extension may be a little relaxed. When at length the patient is permitted to leave his bed, a pair of crutches is indispensable; and during the following two months but little weight should be borne upon the limb.

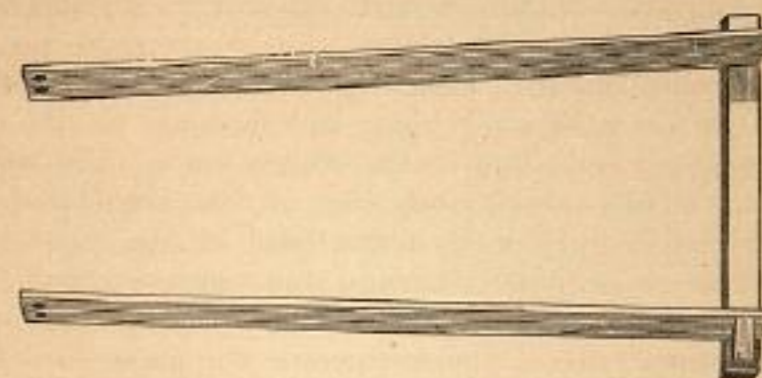
*Fractures of the thigh in children* have generally been found more difficult to manage than fractures of the same bone in the adult, owing chiefly to the shortness and softness of the limb, the delicacy of the skin, its liability to become excoriated, or to become soiled, and the restlessness of the patient. I have tried nearly all forms of apparatus in these cases, including double-inclined planes, boxes, single long splints, etc., and the result of my experience is that they are all inefficient; and for some years I have employed a mode of dressing, partly my own and partly the suggestion of others, but of which I am able to say that it never disappoints me in the result obtained; while it is simple, easy of management, and comfortable to the little patients.

Extension by means of adhesive plaster and a weight employed in the same manner as in adults, constitutes a valuable aid in many cases; but I cannot say that it is indispensable, since, with children under five or seven years, the fractures are pretty often so nearly transverse that, when once reduced and well supported by lateral splints, union without shortening may generally be expected; but these results become less and less frequent as we advance toward adult life. It is safe and proper, according to my experience, to employ in any case extension, somewhat according to the following rule. One pound for a child one year old,

two for a child two years old, and so on, adding one pound for every year up to the twentieth. Of much more consequence, however, is it to confine, at the same time, both limbs, for as long as one is at liberty it is almost impossible to secure any degree of quiet. It is of equal importance, in my opinion, to give to the limbs an extended rather than a flexed position.

My plan of treatment, therefore, in the case of children, is in all essential respects the same as in adults, except that instead of one long side-splint, I employ two. The accompanying illustrations will explain

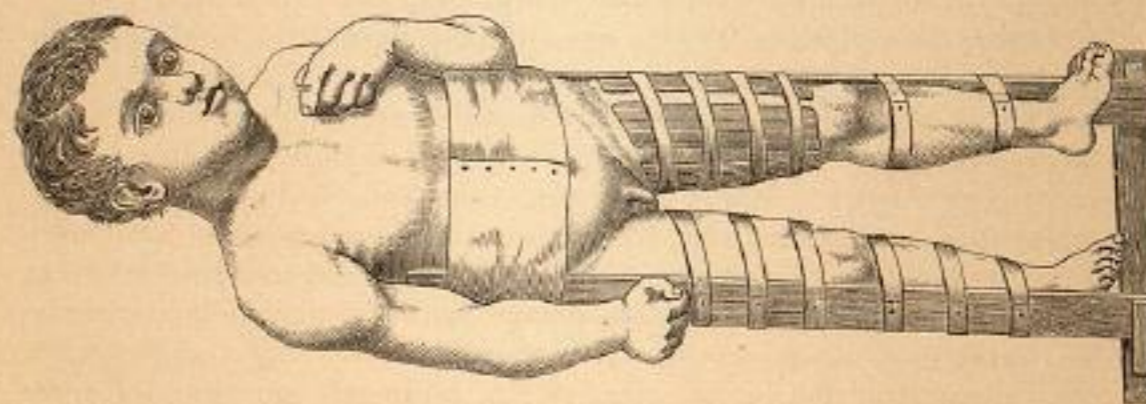
FIG. 200.



Author's splint for fracture of the femur in children.

more fully my meaning. Two long side-splints connected by a cross-piece at the lower ends, and reaching upwards to near the axillæ, sepa-

FIG. 201.



Author's dressing for fracture of the femur in children, complete.

rated a little more widely below than above, so as to render the perineum more accessible, are laid upon each side of the body. The four short thigh splints, made of binders' board and covered with cotton cloth, are secured in place by four or five strips of bandage tied in front and then stitched to the covers of the splints. These must not embrace the long side-splint. The broken limb below the knee, and the opposite thigh and leg are then secured to the long splints by separate and broader strips of cloth. My object in substituting, in this case, separate strips for the roller, is to render the limb more accessible to the surgeon, to enable him more readily to remove portions which are soiled, and to leave the leg

more free to be drawn downwards, in case permanent extension is employed.

Thus secured and laid upon a bed, such as I have already described as appropriate for children, the least possible annoyance will be given to the surgeon. The dressings are but little liable to become wet with urine, and when the bed is soiled, the child can be taken up with the splint and carried to another; indeed, this may be done as often as the patient becomes restless or weary, without any risk of disturbing the fracture.

In case the surgeon desires to use extension with adhesive plaster and weights, the necessary apparatus may be made fast to the bedstead, and taken off when the child is moved; or it may, if thought best, be made fast to the foot-piece of the splint.

Occasionally, with children, I employ, as a means of extra safety, a perineal band, drawn moderately tight, and fastened to the top of the splint on the side corresponding to the broken limb. The best perineal band is a piece of soft cotton cloth, one or two yards long by three inches wide, folded lengthwise to a flat band of one inch in breadth, and inclosing, where it passes through the perineum and under the nates, a few thicknesses of paper. The paper prevents its drawing into a round cord. Sometimes I place between the paper and the folded cloth, on the side which is to be laid next to the skin, one or two thicknesses of cotton-wadding. To absorb the moisture, it is well to lay a piece of sheet lint between the band and the skin. The perineal band may be removed daily and renewed; and the perineum examined and washed.

Four or five weeks is generally a sufficient length of time for perfect consolidation, in children under five years of age.<sup>1</sup>

If I have been unable to give my approval to the treatment of fracture of the shaft of the femur in adults with plaster of Paris, or to any other form of immovable dressing, I am still less able to give it my approval in fracture of the same bone in children. The following case will illustrate its dangers: A boy, four years old, fell thirty feet, breaking his right thigh near its middle, causing one of the fragments to protrude through the flesh. The surgeon in charge, having reduced the fracture, applied on the fifth day a plaster-of-Paris splint from the toes to the groin, leaving a fenestra opposite the wound in the thigh. The child suffered much pain that night, and on the following morning his toes were cold. On the second morning after the dressing there were vesications on the toes. On the fourth day the toes were discolored, and an offensive odor escaped from the dressings. The dressings were now removed, and the toes, with a part of the foot, were found to be gangrenous. Subsequently the gangrene extended to the middle of the leg. This case had been seen and the condition of the toes noted each day by the surgeon, but he did not become alarmed until the fourth day. The surgeon in attendance was then dismissed and another called, by whom I was immediately consulted, at my house, as to the proper course to be

<sup>1</sup> Fractures of Shaft of Femur in Children. A clinical lecture by the author at Bellevue, Med. Rec., Jan. 5, 1878.

pursued. I advised the continuous hot water bath as preferable to amputation under the circumstances, in accordance with my published experience in numerous cases of traumatic gangrene.<sup>1</sup> The surgeon adopted my suggestion, and in about three weeks the limb separated spontaneously, the gangrene having never extended after the limb was submerged in the bath. His recovery has been complete.<sup>2</sup>

In 1877, Dr. Schede, of Berlin, adopted a method of treating fracture of the thigh in children, which he calls "vertical extension." Dr. Kümmel,<sup>3</sup> of Hamburg, endorses the practice, and has reported twenty-eight cases treated by this method, twelve of the patients being less than a year old, and sixteen between the ages of one and two years; the usual result being union within three weeks, without shortening or displacement.

The method of treatment is as follows: "A long continuous band of plaster is fixed to both sides of the injured limb, as high as the seat of fracture, and applied so as to form a free loop below the sole. This long strip is then secured in the ordinary way by circular strips of plaster, and by circular turns of a bandage. The leg, having been elevated, is then kept in the vertical position, with the corresponding side of the pelvis suspended by means of a piece of cord fixed to the loop of plaster, and either attached above to some object over the bed, or slung over a pulley, with its free extremity supporting a weight." This does "not necessitate constant and complete rest on the back." At the end of about three weeks, when the fragments are usually consolidated, the extension is removed, and the limb is permitted to rest upon the bed.

It must be understood, however, that with any mode of treatment, almost, occasional good results are obtained; but this is only because fractures of the thigh in infants are generally green-stick fractures; and the tendency to displacement is very slight, and union occurs very speedily. On the other hand, when these fractures have been treated by plaster of Paris, double-inclined planes, simple side-splints, etc., every now and then the results have been very bad, and sometimes disastrous.

One need not be surprised, therefore, that Dr. Schede, or any other practical surgeon, rather than employ the usual methods, should adopt a plan so entirely novel and radical. As between his method and most other methods, I do not hesitate to say at once that his is, in my opinion, by far the best.

The advantages claimed by Dr. Kümmel for Dr. Schede's method are, that it does not necessitate constant and complete rest upon the back; and that it is simple, efficient, and does not cause pain or discomfort to the patient.

The only disadvantage stated is the occurrence, in some cases of females, of a severe vaginal catarrh, due, as is supposed, to the free entrance of air into the gaping ostium vaginae; but which is quite as likely

<sup>1</sup> Warm and Hot Water in Surgery. By my late pupil, Dr. Fred. E. Hyde. Buff. Med. Journ., Dec. 1875; Trans. N. Y. State Med. Soc., 1875; Richmond and Louisville Med. Journ., Jan. 1874; New York Med. Rec., May 15, 1874, with various other papers by the author.

<sup>2</sup> Medical Record, March 15, 1879, p. 257, case reported by Dr. Forest.

<sup>3</sup> Schede, Kümmel, Berliner Klin. Woch., No. 4, 1882.

to be the result of the lateral stretching of the labia as of the entrance of air.

I shall be excused if I institute a brief examination of the merits of this method as compared with the merits of the method of horizontal extension recommended and adopted by myself.

Dr. Kümmel has very frankly stated one objection which does not apply to horizontal extension, namely, a severe vaginal catarrh; and this alone would be sufficient objection, in my opinion, to its employment in the case of females. Admitting that it will prove, in most cases, to be only temporary, yet it may not in certain constitutions or habits of body cease with the removal of the cause; and no assurance can be given that the inflammation may not be propagated upwards, and thus lay the foundation of serious future uterine trouble. The mere possibility of such a result is sufficient to condemn the practice, as applied to this class of cases.

A second objection I find in the fact that by Schede's method the patient is during the entire period of treatment confined to the bed, while in horizontal extension he is not.

Singularly enough, almost this same argument is employed by Kümmel in favor of Schede's method. "It does not necessitate constant and complete rest on the back." In other words, the patient may turn over more or less upon his side without disturbing the fracture. This statement, it is evident, must be received with some reserve. In a large proportion of cases where the children are under two years the fracture is a green-stick fracture, and often it may be termed a mere bending of the bone; and in all such cases a certain freedom of motion may be permitted without causing either lateral or rotary displacement; but there must be a limit to the freedom of motion of the body even in these cases.

The case is very different, however, when, as occasionally happens—pretty often, indeed—the fracture is complete, and the fragments have been once permitted to overlap or slide upon each other in the direction of the axis of the bone. In such cases there could be no assurance given, where the patient was subjected to no restraints whatever, that union might not be delayed; and, in some cases, that the fragments might not unite with some degree of rotary displacement. No doubt the close apposition of the muscles will tend to prevent this unfortunate occurrence to a great extent; but then, it seems unnecessary to say, the danger of its occurrence is greater where such perfect freedom of motion is permitted.

If, however, it were to be conceded that some motion of the body is admissible, and that Schede's method permits the patient to relieve the back by turning occasionally upon the side, still it must be observed that the extension apparatus, upon which Schede alone relies to adjust and retain the fragments, does not permit the patient for one moment to leave the bed. In Schede's method the extension apparatus is a fixture, and its position cannot be changed, nor can it ever be relaxed.

On the other hand, in horizontal extension the body is not indeed permitted to roll from side to side, but the patient, inclosed in the splint, and including even the extension apparatus, may be taken from one bed to

another, or taken out of doors, as often as we choose. The patient may be put temporarily into almost any position which necessity or comfort may require.

Further than this, in horizontal extension the surgeon does not rely solely upon the extension made by weight and pulley, to keep the fragments in line, so that these may at any time be temporarily removed without affecting the result. Indeed, in many cases this portion of the apparatus is not employed by myself; and I sometimes omit also the lateral splints.

Nor is it so irksome for infants to lie on their backs three or four weeks if only they be permitted to use their hands, as some would suppose. In fact, after the first day they seem perfectly reconciled to it; while, if permitted to move, they are for a time constantly causing themselves pain by some sudden twist of the limb.

I have not spoken of the inconvenience which must be experienced in the vertical extension in the adjustment of the coverings, and especially in cold weather, which inconvenience is avoided in horizontal extension.

It must be added, also, that although in children of this age the fragments are usually firm in three or four weeks, it has not been found safe, in my experience, to remove wholly restraints until a week or two later. The contrary practice has every now and then resulted in a bending at the seat of fracture, which had subsequently to be remedied. My double splint, with only moderate confinement of the body and limbs, without extension or short splints, prevents this unfortunate accident in the later days of the treatment, while in Schede's method the limb must be left, after the extension is removed, wholly without support. In one of Kümmel's patients the extension had to be continued 104 days, and in another 111.

Finally, if we are to compare results, no evidence is presented by Kümmel that his results are any better than my own, by which latter method rotary displacement is impossible; lateral displacement or bending, improbable; and there is no shortening, of course, unless it is a complete fracture, and if it occurs then it is trivial.

The treatment of compound fractures of the thigh, caused by gunshot injuries, will be considered in the chapter devoted to Gunshot Fractures. Other badly comminuted and compound fractures of this bone are to be managed upon the same general principles as gunshot fractures.

Those compound fractures of the femur which have been caused by the thrusting of the sharp fragments through the flesh, and in which reduction has been easily effected, have in most cases done as well as simple fractures, except that the limb is generally a little more shortened. The wound usually soon heals, and the future progress of the case is the same as that of a simple fracture. They may be treated, therefore, in the same manner as those which have just been described.

##### § 5. Fractures of the Shaft, at or near the Base of the Condyles.

These fractures are not so common as fractures of the shaft elsewhere. Only twenty examples are contained in my records as having come under my personal observation. Malgaigne thinks they are caused generally by direct blows, but this was not Sir Astley Cooper's opinion, and ac-